been incapacitated. These figures, when analyzed, show very distinctly that the illnesses among the well-to-do families were normally of much briefer duration than were the illnesses of the poverty stricken.

The authors very wisely caution the reader against assuming that the figures here given prove that poverty is the dominant cause of sickness. As a matter of fact, it is doubtless true that some of the poverty is caused by illness of those supporting the family, resulting in their inability to earn wages. To a larger extent, probably, poverty arises from low earning power, due to low efficiency, and this in turn is a product of a varying mixture of bad heredity, improper nourishment, and lack of education, the last two of which are caused largely by poverty. And so the endless chain moves on!

But this does not at all detract from the value of the facts presented. The investigation appears to demonstrate quite conclusively that, whatever the causal sequence, poverty and disability go hand in hand. It follows, then, if health conditions are so closely bound up with the economic circumstances of the persons under consideration, that conclusions derived from any study of sickness rates which fails to take account of family income must, necessarily, be subject to grave doubts as to their validity.

On the whole, the study furnishes a valuable contribution from the point of view of the economist as well as from that of the scientist interested primarily in questions pertaining to health.

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Introduction to Mathematical Statistics. By CARL J. WEST. (Columbus: R. G. Adams and Company. 1918. Pp. 150.)

This attractive book should appeal to every worker who deals with any kind of statistical material. Among its noteworthy features are: a clear exposition of the best methods of plotting data, smoothing curves, and testing goodness of fit, with applications to fluctuations of prices, rainfall, yield of crops, etc.; a careful explanation of the significance of a frequency distribution, and of the various weighted averages, more especially the standard deviation from the mean, and the use of the normal frequency (or probability) curve in various statistical problems; an unusually complete and lucid treatment of the three chief indices for measuring the degree of relationship between two varying characteristics, namely, the correlation ratio, the coefficient of corre-

lation, and the coefficient of contingency, showing to what kinds of material the three methods are respectively appropriate, and giving their practical significance, with various useful cautions, and a section on spurious correlation; also a welcome chapter on the methods of moments, and its application to curve fitting, with simplified processes for computing the moments of different orders and checking results.

No knowledge of calculus is assumed except in appendix I, which gives an excellent summary of Karl Pearson's formulas for smoothing data by fitting the generalized frequency curves of appropriate type. It may be well to warn the reader that in some of the formulas the printer has confused the Greek letters γ and ν, and that in the enumeration on page 138, type II in the fourth line should be type VII with $\beta > 3$, and type VII should be type VI. The classification adopted is that given by Pearson himself in *Tables for Statisticians and Biometricians* (1914), and differs somewhat from earlier classifications.

In the second edition it would, perhaps, be desirable to insert another appendix presuming an elementary knowledge of calculus, and giving a proof of the equation of the normal probability curve, and the resulting principle of least squares. It would then be possible to show that the method of moments used in determining the line of regression in the chapter on correlation, furnishes the most probable value of the slope of that line; also that in fitting parabolas of any order the method of moments gives the same result as the method of least squares, and hence gives the most probable fit, a fact which originally suggested to Professor Pearson the extension of the method of moments to cases where the method of least squares is not applicable.

A slight knowledge of calculus would also enable the student to understand the important "law of propagation of error" by which one can find the probable error of a function of several variables whose respective probable errors are given.

Another useful statistical formula which could be included is that of Bernoulli, which gives the frequency of a given random deviation from the normal (or expected) number of successes in repeated trials. This would furnish an approximate answer to such practical questions as the following: In a town of 15,000 inhabitants the normal annual death rate is 14 per thousand; but in a certain year it was 16 per thousand; what are the odds against a deviation as great as this being due to pure chance, without any significant change in sanitary conditions?

There is no dearth, however, of practical statistical examples and exercises in this interesting book. They are well graded to illustrate the various principles in the text, and should make the work very welcome to instructors of college classes as well as to statisticians in general.

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JAMES MCMAHON.

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The Mathematical Theory of Population, of its Character and Fluctuations, and of the Factors which Influence them. By G. H. KNIBBS. Appendix A, Volume 1, Census of the Commonwealth of Australia. (Melbourne: Commonwealth Statistician. 1917. Pp. xvi, 466.)

The author says in his foreward that this monograph "aims on the one hand at supplying the elements of a mathematical technique, such as are needed for the analysis of the various aspects of vital phenomena that come under statistical review, and, on the other, at interpreting material made available by the first Census of Australia which has been carried out upon uniform lines and by a central authority." The results of the study "have brought into clearer relief the necessity for recognizing that the variation of any one statistical element affects all other statistical elements, so that the satisfactory reduction of 'crude data' to a common system is by no means an easy undertaking, and the comparability of the statistic of two communities can never be rigorously exact in all particulars."

The scope of this highly technical mathematical analysis may be gleaned from a brief description of its contents. The first eight chapters are devoted mainly to method, such topics as the following being discussed: types of population fluctuations; curve constants and intermediate values; types of curves and their characteristics; group value and integration for statistical aggregates; the place of graphics and smoothing in the analysis of population statistics; conspectus of population characters.

In these chapters primary emphasis is given to the development of mathematical formulas to describe population distributions and the curves which represent them. Among other things discussed are types of population fluctuation, note being taken of the determining factors which secularly influence rate of population increase. A large amount of comparative data on population growths is given for the important countries of the world and the likelihood and consequence of such a rate continuing are pointed